DRAFT

October 6, 2020

## Project Portal Cover Page

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|---|---|
| **To:** | USEPA |
| **Cc:** | NCG, NYC |
| **From:** | David Haury, Anchor QEA, LLC |
| **Re:** | Proposed Revised Interim PRGs for PAHs Document |

The Proposed Revised Interim PRGs for PAHs document is now posted on Project Portal. The document responds to USEPA concerns related to the use of the porewater TPAH and reference area datasets and proposes a revised risk-based TPAH (34) interim PRG that optimizes the use of the comprehensive porewater and reference area datasets compiled for the BERA and that will be protective of the health of the benthic community throughout the Study Area. The NCG looks forward to discussing this revised approach with USEPA.

DRAFT


October 2020
Newtown Creek RI/FS

ANCHOR QEA

# Proposed Revised Interim Preliminary Remediation Goals for Polycyclic Aromatic Hydrocarbons

Prepared for the Newtown Creek Group

DRAFT

October 2020
Newtown Creek RI/FS

# Proposed Revised Interim Preliminary Remediation Goals for Polycyclic Aromatic Hydrocarbons

**Prepared for**
The Newtown Creek Group

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Project Number: 201037-01.01
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# ABBREVIATIONS

| | |
|---|---|
| BERA | *Baseline Ecological Risk Assessment* |
| GC | Gerritsen Creek |
| HB | Head of Bay |
| $K_{oc}$ | organic carbon partitioning coefficient |
| MDL | method detection limit |
| mg/kg | milligrams per kilogram |
| NCG | Newtown Creek Group |
| PAH | polycyclic aromatic hydrocarbon |
| PRG | preliminary remediation goal |
| $r^2$ | coefficient of determination |
| SC | Spring Creek |
| TOC | total organic carbon |
| TPAH | total polycyclic aromatic hydrocarbon |
| TU | toxic unit |
| U | non-detect |
| USEPA | U.S. Environmental Protection Agency |
| WE | Westchester Creek |

# 1 Introduction

The Newtown Creek Remedial Investigation/Feasibility Study process for determining risk-based total polycyclic aromatic hydrocarbon (TPAH) interim preliminary remediation goals (PRGs) is based on the sediment triad data that were presented in the *Baseline Ecological Risk Assessment* (BERA; Anchor QEA 2018), which includes benthic community, toxicity, and porewater and bulk sediment chemistry information. At a June 18, 2020 presentation to the Newtown Creek Group (NCG), the U.S. Environmental Protection Agency (USEPA) proposed an interim PRG for TPAH (34) based on the correlation between 28-day survival and bulk sediment TPAH (34) concentrations. USEPA also provided a 28-day survival versus bulk sediment C19-C36 aliphatic hydrocarbon interim PRG of 200 milligrams per kilogram (mg/kg). In its presentation, USEPA concluded that the BERA porewater data did not lend itself to a porewater-based approach to PRG development and articulated additional concerns with the reference area dataset.

The NCG appreciates the feedback from USEPA and understands USEPA's concerns with specific aspects of the porewater TPAH and reference area datasets. This proposal addresses these concerns in an effort to derive a risk-based TPAH PRG that optimizes the use of the comprehensive porewater and reference area datasets compiled for the BERA that will be protective of the health of the benthic community throughout the Study Area. The overall objectives of this proposal are as follows:

- Address USEPA's specific concerns regarding the use of the TPAH porewater dataset to derive a sediment TPAH (34) PRG.
- Provide two approaches for deriving a TPAH (34) PRG based on converting a porewater TPAH toxic unit (TU) = 1 to a bulk sediment TPAH (34) concentration (a threshold approach and a regression approach).
- Evaluate the effectiveness of the TPAH (34) PRGs derived from these approaches in discriminating toxic versus non-toxic samples based on a porewater TPAH (34) TU = 1 threshold and a 28-day survival threshold.
- Demonstrate that the proposed sediment TPAH (34) PRG will also address the C19-C36 aliphatic hydrocarbons without the need for a separate aliphatic PRG.

Table 1 summarizes the Study Area triad data that are included in the following evaluations: 28-day survival, porewater TPAH (34) TU, sediment concentrations of TPAH (34) and C19-C36 aliphatic hydrocarbons, and percent total organic carbon (TOC).

Section 2 presents the two approaches for deriving a sediment TPAH (34) PRG, Section 3 evaluates the effectiveness in differentiating toxic versus non-toxic samples for the two estimates, and Section 4 presents a summary of the revised TPAH (34) PRG approach and the recommended TPAH (34) PRG.

**Table 1**
**Newtown Creek Sediment Triad Data Summary of 28-Day Survival, PAHs, Hydrocarbons, and Select Parameters for PRG Development**

| Location ID | Creek Mile | 28-Day Control-Adjusted Percent Survival | Porewater TPAH (34) TU (U = 1/2 MDL) | TPAH (34) (mg/kg) | C19-C36 Aliphatic (mg/kg) | TOC (%) |
|---|---|---|---|---|---|---|
| NC153SG | 0.052 | 76.6 | 0.23 | 95.1 | 41.1 | 3.04 |
| NC154SG | 0.155 | 95.5 | 0.24 | 70.5 | 24.3 | 3.49 |
| NC156SG | 0.262 | 83.6 | 0.24 | 80.4 | 76.2 | 3.66 |
| NC158SG | 0.344 | 78.1 | 0.23 | 51.3 | 45.4 | 3.46 |
| NC161SG | 0.624 | 90.2 | 0.46 | 72.4 | 28.8 | 4.03 |
| NC162SG | 0.773 | 75.0 | 0.36 | 71.8 | 19.1 | 4.1 |
| WC010SG | 0.936 | **54.7** | **5.5** | 149 | 477 | 4.28 |
| WC012SG | 1.066 | **64.4** | **3.2** | 237 | 407 | 5.63 |
| DK001SG | 0.904 | 88.6 | 0.88 | 92.4 | 164 | 4.06 |
| DK037SG | 1.251 | **12.9** | **1.3** | 193 | 1,960 | 14.9 |
| DK040SG | 1.398 | **13.3** | 0.35 | 196 | 1,120 | 10.7 |
| NC164SG | 1.105 | 96.2 | 0.24 | 58.1 | 36.1 | 3.55 |
| NC037SG | 1.254 | 77.3 | 0.64 | 99.3 | 46.6 | 4.1 |
| NC165SG | 1.395 | 97.0 | 0.24 | 70.9 | 23.3 | 4.17 |
| NC046SG | 1.536 | 86.7 | 0.26 | 73.2 | 75.8 | 4.05 |
| NC167SG | 1.746 | **60.2** | 0.23 | 76.7 | 299 | 3.82 |
| NC168SG | 1.918 | **66.4** | 0.36 | 181 | 334 | 5.16 |
| NC169SG | 1.984 | 76.6 | 0.24 | 105 | 121 | 7.41 |
| NC065SG | 2.231 | **43.0** | 0.27 | 164 | 915 | 12.9 |
| NC174SG | 2.353 | **0.0** | **16** | 803 | 580 | 8.65 |
| NC071SG | 2.432 | **0.0** | **92** | 1290 | 1,990 | 8.82 |
| MC017SG | 2.441 | **15.9** | 0.60 | 252 | 3,640 | 16.9 |
| MC005SG | 2.517 | **25.8** | 0.90 | 221 | 1,120 | 13 |
| MC023SG | 2.624 | **7.0** | **2.6** | 394 | 1,960 | 9.28 |
| NC293SG | 2.561 | **0.8** | **9.9** | 1230 | 978 | 4.71 |
| NC180SG | 2.637 | **5.5** | **178** | 678 | 2,040 | 9.73 |
| NC181SG | 2.817 | **12.9** | **8.8** | 551 | 3,370 | 7.88 |
| EK057SG | 3.024 | **9.1** | **149** | 875 | 385 | 12.4 |
| EK006SG | 3.07 | **3.0** | **18** | 1950 | 9,590 | 12.7 |
| EK059SG | 3.303 | **1.5** | **269** | 1810 | 17,000 | 13.9 |
| EK065SG | 3.505 | **6.8** | **12** | 391 | 3,630 | 11.6 |
| EK072SG | 3.62 | **8.3** | **3.4** | 708 | 3,580 | 16.5 |
| EK076SG | 3.801 | **0.0** | **6.6** | 681 | 12,100 | 12.2 |
| EB036SG | 3.127 | **8.6** | 0.53 | 305 | 1,770 | 13.7 |
| EB006SG | 3.065 | **9.8** | 0.87 | 364 | 1,900 | 17 |

Note:
**Red, bolded, and underlined** values indicate 28-day survival less than 70% or TPAH (34) TU greater than 1 TU.

Abbreviations:
MDL: method detection limit
mg/kg: milligrams per kilogram
PAH: polycyclic aromatic hydrocarbon
PRG: preliminary remediation goal
TOC: total organic carbon
TPAH: total polycyclic aromatic hydrocarbon
TU: toxic unit
U: non-detect

# 2 Revised Porewater-Based Interim TPAH PRG Approach

The purpose of this section is to propose revisions to the porewater-based derivation of a TPAH PRG, taking into account USEPA's concerns with the porewater dataset (i.e., data treatment and interferences). Based on USEPA's data treatment applied in the June 18 presentation of proposed interim PRG derivations, the following conventions were adopted:

- **Use non-detect (U) = 1/2 method detection limit (MDL) for porewater TPAH (34) TU and bulk sediment TPAH (34).**
- **Use TU = 1 as the PRG porewater TPAH (34) threshold.** A threshold of 1 TU is a value intended to be protective of chronic effects to 95% of aquatic species (USEPA 2003). It is a no observable effect concentration and is an appropriate threshold to evaluate the protectiveness of a sediment TPAH (34) concentration that corresponds to a porewater TU = 1.
- **Use a 70% survival threshold to evaluate effectiveness of sediment TPAH (34) PRG.** USEPA selected a 75% survival level as an acceptable toxicity threshold for purposes of deriving a PRG. The NCG provides analyses herein supporting that a 70% survival threshold is valid, because it incorporates the reference area toxicity test results, while also being responsive to USEPA's concerns about the use of some of the reference area data from Westchester Creek. Specifically, USEPA considers some triad stations in Westchester Creek (WE) as impacted and not suitable for consideration as a reference condition, due to low survival for three head of waterway stations (WE014, WE013, WE012). However, for the other three reference areas—Spring Creek (SC), Gerritsen Creek (GC), and Head of Bay (HB), either individually or combined—28-day survival converges on approximately a 70% toxicity threshold (see Table 2). Because it is important to capture the full range of reference area results, the approximate 70% toxicity threshold resulting from the use of the full reference area dataset minus the three impacted WE samples (see Table 3) is a technically supportable threshold for evaluating whether the proposed TPAH (34) PRG can differentiate stations that are toxic versus non-toxic.

**Table 2**
**Reference Envelope Values for the *Leptocheirus* 28-Day Survival (derived from Table 8-12b in the BERA)**

| Individual Area (n = 12)<br>Endpoint (Control-Adjusted % Response) | Distribution | 95% Lower Confidence Limit on the 5th Percentile |
|---|---|---|
| **Gerritsen Creek** | | |
| 28-Day Survival | Weibull | 70.6 |
| **Spring Creek** | | |
| 28-Day Survival | Weibull | 72.6 |
| **Head of Bay** | | |
| 28-Day Survival | Weibull | 69.3 |
| **All Reference Areas Without Westchester Creek (n = 36)<br>Endpoint (Control-Adjusted % Response)** | **Distribution** | **95% Lower Confidence Limit on the 5th Percentile** |
| 28-Day Survival | Weibull | 71.9 |

Abbreviation:
BERA: *Baseline Ecological Risk Assessment*

**Table 3**
**Reference Envelope Values for the *Leptocheirus* 28-Day Survival (derived from Table 8-12a in the BERA)**

| All Reference Areas (n = 48)<br>Endpoint (Control-Adjusted % Response) | Distribution | 95% Lower Confidence Limit on the 5th Percentile |
|---|---|---|
| 28-Day Survival | Weibull | 59.7 |
| **All Reference Areas Without WE014, WE013, WE012 (n = 42)<br>Endpoint (Control-Adjusted % Response)** | **Distribution** | **95% Lower Confidence Limit on the 5th Percentile** |
| 28-Day Survival | Weibull | 70.9 |

Abbreviation:
BERA: *Baseline Ecological Risk Assessment*

Section 2.1 presents a determination of a sediment TPAH (34) PRG based on a TU threshold approach and Section 2.2 presents a determination of a sediment TPAH (34) PRG based on a regression approach.

## 2.1 Porewater TU Threshold Approach to Derive TPAH (34) PRG

The following approach follows USEPA methods to define PRG(s) that discriminate toxic from non-toxic stations based on a porewater TPAH (34) TU threshold value of 1. It follows USEPA (2017) guidance for translating porewater TPAH (34) TUs into a sediment TPAH (34) PRG, as follows:

- Rank order the Study Area triad dataset (n = 35) based on increasing porewater TPAH (34) TUs (see Table 4).
- Select two stations that bracket TPAH (34) TU = 1. The two stations that bracket a TU = 1 are as follows: MC005SG (TU = 0.9; sediment TPAH [34] = 221 mg/kg) and DK037SG (TU = 1.3; sediment TPAH [34] = 193 mg/kg).
- For these two stations, convert the porewater TU values into sediment TPAH (34) benchmarks (i.e., TU-normalize the bulk sediment concentration) using the following approach to compute a sediment TPAH (34) PRG corresponding to a porewater TPAH (34) TU = 1:
  - Divide the sediment TPAH (34) concentration by the associated TU (i.e., for MC005SG: 221 mg/kg/0.9 TU = 245 mg/kg; for DK037SG: 193 mg/kg/1.3 TU = 148 mg/kg).
- To be conservative, select the lower value as the interim PRG TPAH (34) = 148 mg/kg.

The performance of this PRG is discussed further in Section 3.

**Table 4**
**Rank Order of Newtown Creek Sediment Triad Data Porewater TPAH (34) TU with 28-Day Survival, and Sediment PAHs, for PRG Development**

| Location ID | Creek Mile | 28-Day Control-Adjusted Percent Survival | Porewater TPAH (34) TU (U = 1/2 MDL) | TPAH (34) (mg/kg) |
|---|---|---|---|---|
| NC153SG | 0.052 | 76.6 | 0.23 | 95.1 |
| NC158SG | 0.344 | 78.1 | 0.23 | 51.3 |
| NC167SG | 1.746 | **60.2** | 0.23 | 76.7 |
| NC154SG | 0.155 | 95.5 | 0.24 | 70.5 |
| NC156SG | 0.262 | 83.6 | 0.24 | 80.4 |
| NC164SG | 1.105 | 96.2 | 0.24 | 58.1 |
| NC165SG | 1.395 | 97 | 0.24 | 70.9 |
| NC169SG | 1.984 | 76.6 | 0.24 | 105 |
| NC046SG | 1.536 | 86.7 | 0.26 | 73.2 |
| NC065SG | 2.231 | **43** | 0.27 | 164 |
| DK040SG | 1.398 | **13.3** | 0.35 | 196 |
| NC162SG | 0.773 | 75 | 0.36 | 71.8 |
| NC168SG | 1.918 | **66.4** | 0.36 | 181 |
| NC161SG | 0.624 | 90.2 | 0.46 | 72.4 |
| EB036SG | 3.127 | **8.6** | 0.53 | 305 |
| MC017SG | 2.441 | **15.9** | 0.6 | 252 |
| NC037SG | 1.254 | 77.3 | 0.64 | 99.3 |
| EB006SG | 3.065 | **9.8** | 0.87 | 364 |
| DK001SG | 0.904 | 88.6 | 0.88 | 92.4 |
| **MC005SG** | 2.517 | **25.8** | 0.9 | 221 |
| **DK037SG** | 1.251 | **12.9** | **1.3** | 193 |
| MC023SG | 2.624 | **7** | **2.6** | 394 |
| WC012SG | 1.066 | **64.4** | **3.2** | 237 |
| EK072SG | 3.62 | **8.3** | **3.4** | 708 |
| WC010SG | 0.936 | **54.7** | **5.5** | 149 |
| EK076SG | 3.801 | **0** | **6.6** | 681 |
| NC181SG | 2.817 | **12.9** | **8.8** | 551 |
| NC293SG | 2.561 | **0.8** | **9.9** | 1230 |
| EK065SG | 3.505 | **6.8** | **12** | 391 |
| NC174SG | 2.353 | **0** | **16** | 803 |
| EK006SG | 3.07 | **3** | **18** | 1950 |
| NC071SG | 2.432 | **0** | **92** | 1290 |
| EK057SG | 3.024 | **9.1** | **149** | 875 |
| NC180SG | 2.637 | **5.5** | **178** | 678 |
| EK059SG | 3.303 | **1.5** | **269** | 1810 |

Notes:
**Red, bolded, and underlined** values indicate 28-day survival less than 70% or TPAH (34) TU greater than 1 TU.
**Black, bolded** stations are those selected for porewater TU threshold approach (see Section 2.1).

Abbreviations:
MDL: method detection limit
mg/kg: milligrams per kilogram
PAH: polycyclic aromatic hydrocarbon
PRG: preliminary remediation goal
TPAH: total polycyclic aromatic hydrocarbon
TU: toxic unit
U: non-detect

## 2.2 Regression Approach to Porewater-Based TPAH (34) PRG

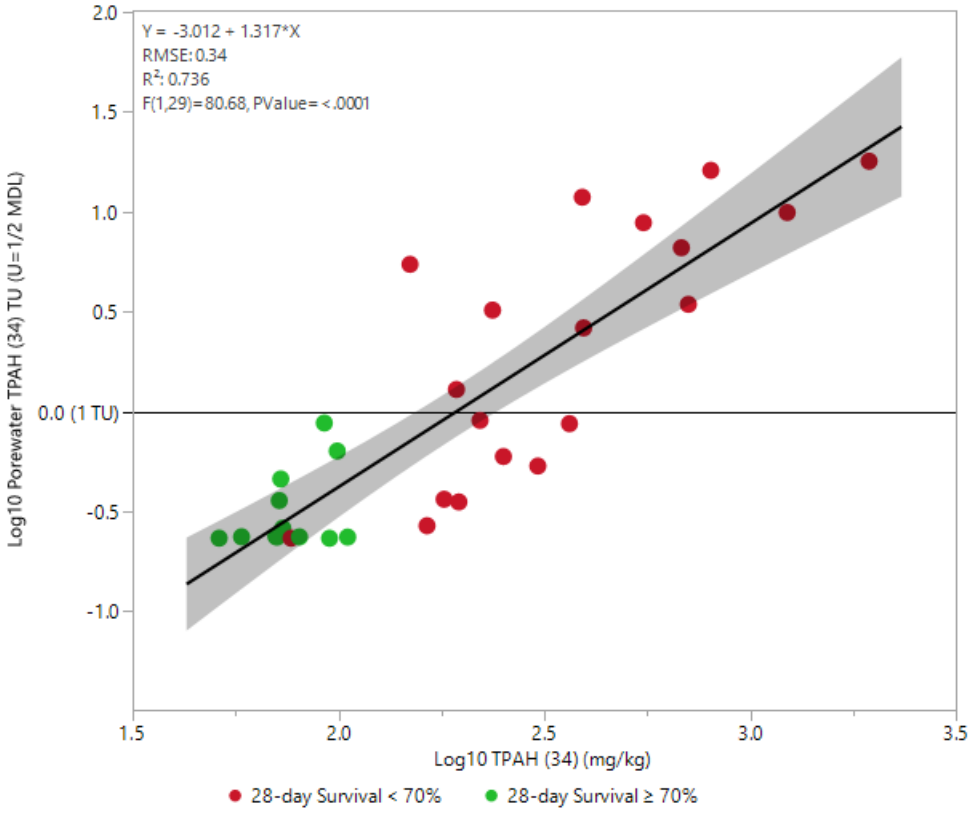
A second approach in this section calculates the TPAH (34) PRG as the inverse prediction of sediment TPAH (34) at a TPAH (34) TU of 1 threshold. Recognizing the variability in the relationship between porewater and 28-day survival, the lower 95% confidence limit on the porewater TPAH (34) TU versus bulk sediment TPAH (34) regression fit forms an appropriate basis for the TPAH (34) PRG.

USEPA raised concerns regarding organic carbon partitioning coefficient ($K_{oc}$) values that are lower than would be expected for natural organic carbon (DiToro et al. 1991). For most stations, none, or only a few, of the polycyclic aromatic hydrocarbon (PAH) analytes have lower than expected $K_{oc}$ values. However, stations EK057, EK059, NC071, and NC180 are four Study Area stations with a large number of analytes that have lower than expected $K_{oc}$ values and TPAH (34) TU values that are much higher than would be expected under normal partitioning and may be a result of sediment matrix/porewater interferences. Filtering the dataset to remove these four samples is reasonable to address this issue raised by USEPA. Removing these four stations results in a dataset with 11 toxic stations with TU values between 1.3 and 18 and 28-day survival from 0% to 64%. Combined with the 20 non-toxic stations (i.e., survival greater than 70% and TUs less than 1), a total of 31 Study Area samples are retained for computing a TPAH (34) PRG.

Figure 1 presents the regression for Log10 porewater TPAH (34) TU versus Log10 TPAH (34) (milligrams per kilogram [mg/kg]). The regression was calculated using JMP (2019) software. The gray shaded region is the confidence interval around the fit of the regression line. The lower 95% confidence interval of the TPAH (34) bulk sediment concentration at TPAH (34) TU = 1 is located along the left edge of the gray region. The coefficient of determination ($r^2$) is 73.6%. The regression with the four highest TPAH (34) TU values removed (n = 31) has a better fit to the data (i.e., 29% lower root-mean squared error) than the same regression with the full Study Area dataset (i.e., n = 35), supporting USEPA's observation that the higher TU stations appeared to be anomalous. Table 5 summarizes the regression results and the lower 95% predicted sediment TPAH (34) (mg/kg) value of 155 mg/kg.

Given the 73.6% association in the log-log regression between TPAH (34) and sediment TPAH (34) (see Figure 1), there is strong evidence that the average partitioning relationship of PAHs is predictable. Figure 1 also illustrates that 1 TU is within the center of the range of Study Area TPAH (34) TU values.

**Figure 1**
**Log10 Porewater TPAH (34) TU versus Log10 TPAH (34)**




Note:
n = 31

**Table 5**
**Summary of Inverse Predictions of Porewater TPAH (34) TU versus Sediment TPAH (34) Regression at 1 TU**

| Survival versus Porewater Regression | Porewater versus Sediment Regression | | | | |
|---|---|---|---|---|---|
| Porewater TPAH (34) TU | Log10 Porewater TPAH (34) TU | Predicted Log10 TPAH (34) (mg/kg) | Lower 95% Predicted Log10 TPAH (34) (mg/kg) | Predicted TPAH (34) (mg/kg) | Lower 95% Predicted TPAH (34) (mg/kg) |
| 1 | 0 | 2.286 | 2.189 | 193 | 155 |

Note:
See Figure 1.

Abbreviations:
mg/kg: milligrams per kilogram
TPAH: total polycyclic aromatic hydrocarbon
TU: toxic unit

# 3 Effectiveness of Proposed PRG

Two similar metrics, survival and TU, are evaluated to ensure the proposed TPAH (34) PRGs using the two different approaches are protective. To do this, a stepwise analysis is conducted to optimize the proposed interim TPAH (34) PRG, with the goal to minimize the number of false negatives (i.e., TPAH concentration is less than PRG, but survival is less than 70%) and false positives (i.e., TPAH concentration is greater than PRG, but survival is greater than 70%). In a similar manner, the TU values were also evaluated to ensure protectiveness.

A graphical analysis also is used to ensure that potential toxicity in the Study Area from C19-C36 aliphatic hydrocarbons (based on the USEPA-proposed interim PRG of 200 mg/kg) is protected by the proposed interim TPAH (34) PRGs. The plot of the bulk sediment TPAH (34) versus C19-C36 aliphatic hydrocarbon concentrations, showing the respective PRGs, is provided in Figure 2, and results in the following observations:

- The USEPA-proposed TPAH (34) PRG of 100 mg/kg has one false negative (NC167) and one false positive (NC169), based on toxicity. All TU values are less than 1 at or below 100 mg/kg.
- The porewater versus sediment TPAH (34) PRG of 155 mg/kg derived using the approach presented in Section 2.2 has two false negatives (NC167 and WC010). Station WC010 has a sediment TPAH (34) concentration of 149.2 mg/kg and a porewater TPAH (34) greater than 1 TU.
- Lowering the interim proposed TPAH (34) PRG to 149 mg/kg results in one false negative (NC167), and no false positives. All TUs are less than 1 at or below 149 mg/kg.
- Compared to the USEPA-proposed interim TPAH (34) PRG of 100 mg/kg, a lower overall error rate for toxicity is achieved, and all TUs are less than 1, at a TPAH (34) PRG value of 149 mg/kg. This value also is consistent with the value of 148 mg/kg TPAH (34) presented in Section 2.1.

Figure 2 also indicates that the TPAH (34) PRG value of 149 mg/kg differentiates potential effects from non-PAH hydrocarbons, as represented by the USEPA-proposed PRG for C19-C36 aliphatic hydrocarbons. Therefore, a separate non-PAH hydrocarbon PRG is not needed. Moreover, there exists some uncertainty around USEPA's proposed C19-C36 aliphatic hydrocarbon PRG value of 200 mg/kg. Based on the Study Area data, C19-C36 aliphatic hydrocarbons appear to have a low-effect concentration of approximately 275 mg/kg (i.e., Station NC167, see Figures 2 and 3). Figure 3 includes only those stations where both bulk sediment TPAH (34) concentrations are less than 149 mg/kg and TPAH (34) TUs are less than 1.

**Figure 2**
**Sediment TPAH (34) versus C19-C36 Aliphatic Hydrocarbons**

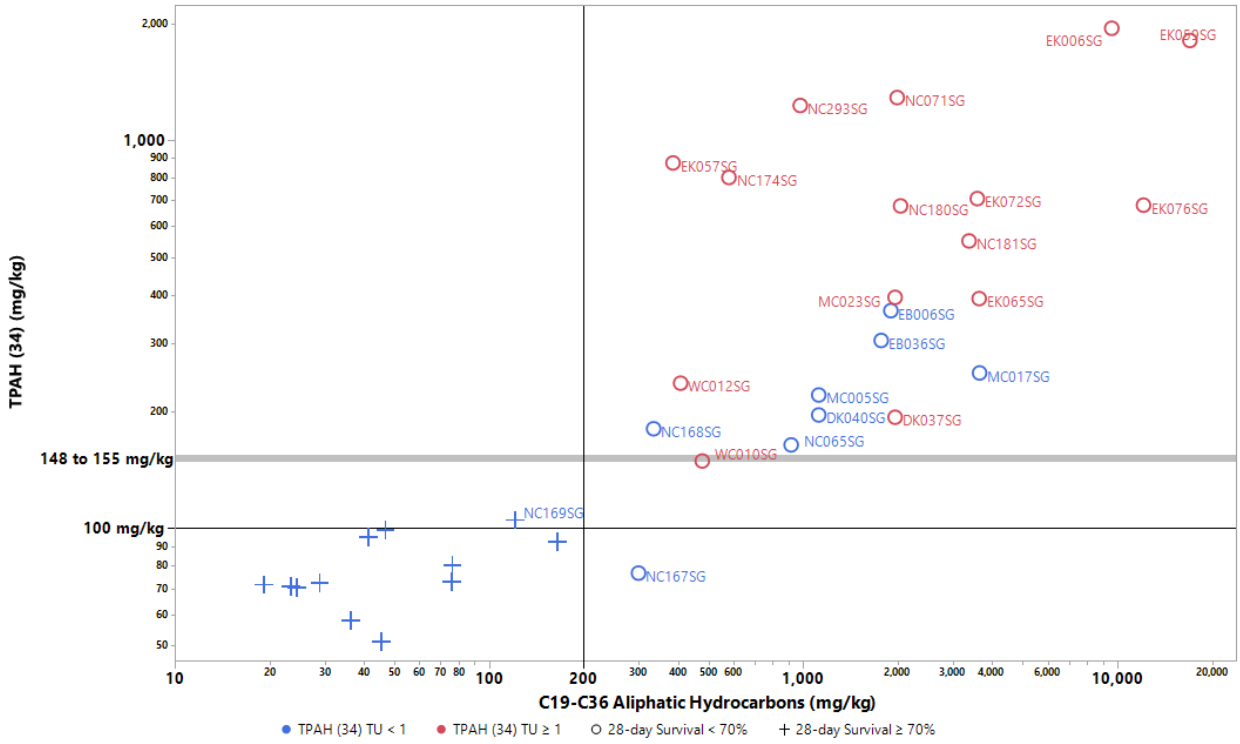
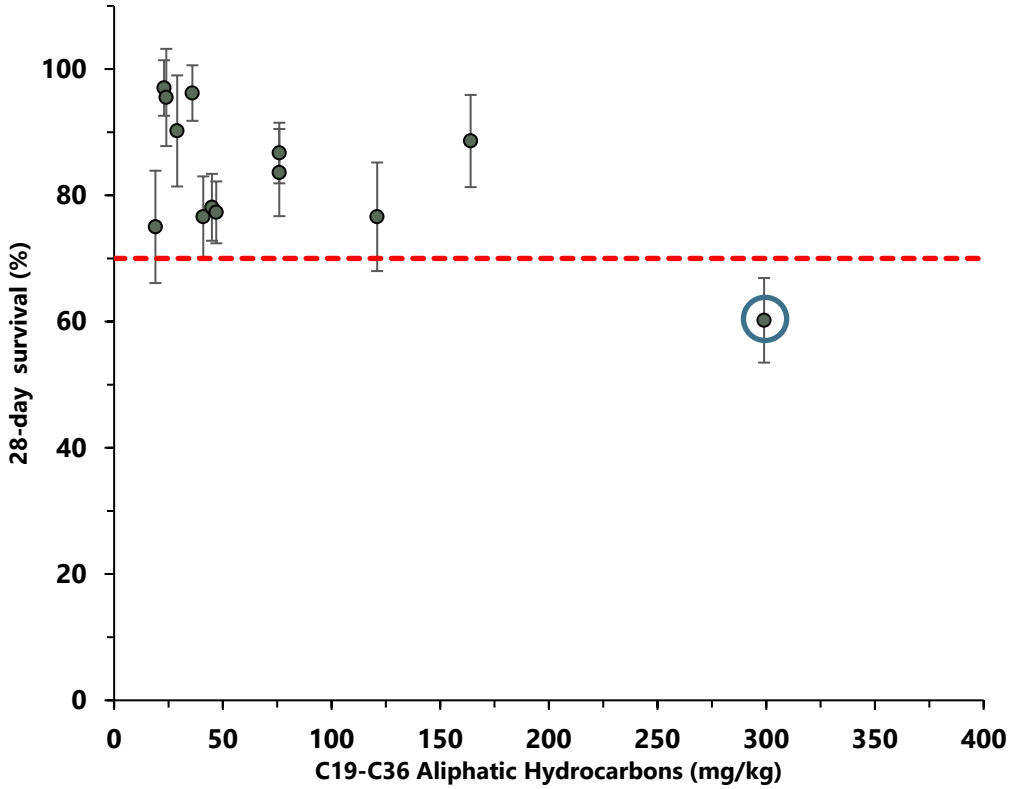


**Figure 3**
**Sediment 28-Day Survival (%) versus C19-C36 Aliphatic Hydrocarbons**




Note: Graph includes only those stations where both bulk sediment TPAH (34) concentrations are less than 149 mg/kg and TPAH (34) TUs are less than 1. The circled value is the only toxic sample, NC167.

# 4 Summary

Using the BERA triad data, a revised porewater-based interim TPAH (34) PRG is provided that addresses USEPA concerns regarding the use of porewater and reference area data.

Two approaches to develop an interim TPAH (34) PRG were used to determine the TPAH (34) sediment concentration at 1 TU, consistent with USEPA guidance (USEPA 2017). These two methods addressed USEPA concerns about using the TPAH (34) porewater data to determine the PRG. The two methods resulted in two TPAH values, 148 mg/kg and 155 mg/kg TPAH (34). A final step to optimize the PRG demonstrated that a bulk sediment TPAH (34) concentration of 149 mg/kg has the lowest error rate of false positive and false negative toxicity results, is in full agreement with the porewater TPAH (34) 1 TU threshold, and is predictive of samples with C19-C36 aliphatic hydrocarbons above the USEPA-proposed PRG of 200 mg/kg at triad locations. Therefore, an interim sediment TPAH (34) PRG of 149 mg/kg is proposed.

# 5 References

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